

REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended claim 1 to recite that the alkylation is performed in the presence of a Broensted acid and without the presence of a Lewis acid. See, for example, the last full paragraph on page 7 of Applicants' specification.

Moreover, Applicants are adding new claims 15-21 to the application. Claim 15, dependent on claim 2, further defines the molar ratio of the Broensted acid to the aromatic compound, consistent with the description on page 7 of Applicants' specification; and claim 16, dependent on claim 1, recites amount of olefin included relative to the amount of the aromatic compound, consistent with the description on page 7 of Applicants' specification. Claims 17-19, dependent respectively on claims 3, 17 and 5, further define the temperature at which the alkylation is performed or at which the isomerization is performed, consistent with descriptions on pages 8 and 9 of Applicants' specification. Claim 20 expressly recites subject matter set forth in claim 5, but is dependent on claim 3. Claim 21, dependent on claim 1, recites that the alkylation and the isomerization are carried out in a same single reaction chamber, consistent with the description, e.g., in the paragraph bridging pages 9 and 10 of Applicants' specification.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed January 30, 2007, that is, the teachings of the U.S. patents to Lien, et al., No. 2,868,854, to Olah, No. 3,766,286, and to Frey, No. 2,372,320, under the requirements of 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a process for producing an alkyl aromatic compound as represented by the general formula (2), in the present claims, including wherein an aromatic compound represented by the general formula (1) is alkylated with a specified olefin in the presence of a Broensted acid and without the presence of a Lewis acid, with a Lewis acid being subsequently added to the resulting alkylation reaction product and the resulting mixture being subjected to isomerization in the copresence of the Broensted acid and the Lewis acid. See claim 1.

Furthermore, it is respectfully submitted that the teachings of these applied references would have neither disclosed nor would have suggested such process as in the present claims, having features as discussed previously in connection with claim 1, and, moreover, molar ratios of various components in the various reactions as in claims 2, 4, 5, 10, 15 and 16; and/or temperature of the alkylation reaction or isomerization reaction as in claims 3, 5, 9, 11 and 17-20; and/or wherein the Broensted acid is HF and the Lewis acid is BF_3 (see claims 6 and 12); and/or wherein the olefin is selected from the group as set forth in claims 7 and 13; and/or the specific substituents of R^1 , R^2 , R^0 and X, as in claims 8 and 14; and/or wherein the alkylation and the isomerization are carried out in a same single reaction chamber (see claim 21).

The present invention relates to a process for alkylation of an aromatic compound having substituents, by alkylating an aromatic compound, having two substituents in the meta positions, with a lower olefin such as ethylene or propylene. The produced alkyl aromatic compound is useful as a raw material for various industries, such as in pharmaceuticals, agricultural chemicals, liquid crystals, functional pigments, solvents and monomers for engineering plastics.

In alkylating an aromatic compound, the position (ortho, meta or para position) of the aromatic ring of the raw material to which an alkyl group is introduced is determined by the effect of the functional groups. When the desired compound is not in accord with the substitution orientation inherent to the functional group, however, a positional isomer of the desired compound is obtained as a product, and it is necessary to carry out a disproportionation reaction, called an isomerization reaction or a transalkylation reaction, in order to introduce the alkyl group to the desired position.

Various techniques have been used for the alkylation, as described on pages 1-3 of Applicants' specification. These alkylation reactions use, as a catalyst, a Lewis acid represented by aluminum chloride; and also well known is an alkylation reaction using a catalyst HF which is a Broensted acid. However, these previously proposed methods have various problems, including a problem in connection with separation and purification of HF used as the catalyst, and wherein the yield of the desired product is undesirably low, or conversion of the raw material is not satisfactory.

Against this background, Applicants provide a process for producing an alkyl aromatic compound having substituents at the 3- and 5-positions, which is high in yield and in selectivity to the desired compound, and which permits easy and efficient recovery and recycling of the catalyst. As described on page 5 of Applicants' specification, the present inventors have found that the desired alkyl aromatic compound having substituents at the 3- and 5-positions can be obtained in a stable manner with a high yield and a high selectivity, under mild and simple reaction conditions, by alkylating an aromatic compound having two substituents at the meta positions with an olefin having 2-4 carbon atoms in the presence of a

Broensted catalyst such as HF, followed by addition of a Lewis acid such as BF_3 and permitting intramolecular isomerization to proceed.

Applicants have found that a Lewis acid hinders the alkylation reaction, and, therefore, should not be used in the alkylation stage. In view thereof, Applicants provide a process achieving effective alkylation and isomerization, by performing the alkylation in the presence of the Broensted acid and without the presence of the Lewis acid, with the Lewis acid subsequently being added and wherein the isomerization takes place in the copresence of the Broensted acid and the Lewis acid. Note the last full paragraph on page 7, and the paragraph bridging pages 7 and 8, of Applicants' specification.

As to advantages achieved according to the present invention, attention is respectfully directed to the Examples and Comparative Examples on pages 10-15 of Applicants' specification. It is respectfully submitted that Comparative Examples 1-7 correspond to the procedure described in Frey, et al., discussed infra; and that Comparative Example 8 compares to the processes in Lien, et al. and Olah, discussed infra, in which an isomerization is carried out under the presence of HF and BF_3 . Thus, it is respectfully submitted that the Examples and Comparative Examples provide a comparison with the closest prior art. This evidence in Applicants' specification must be considered in determining obviousness. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984).

As can be seen in Comparative Examples 2-7 and as discussed in the last full paragraph on page 13 of Applicants' specification, it is seen that, when BF_3 is added in the alkylation reaction stage, good results including a high yield and high selectivity are not obtained, even when amounts of HF and propylene are changed. Note also the results discussed in connection with Comparative Example 8 on page 14 of Applicants' specification, wherein it is described that the product obtained had

a yield of desired 3,5-dimethylcumene of 7%, and the selectivity was 13% and the yield of 2,4-dimethylcumene was 27%. In the Examples according to the present invention, much higher yield and selectivity were achieved.

It is respectfully submitted that the unexpectedly better results achieved according to the present invention, as seen in comparing the Examples and Comparative Examples in Applicants' specification, clearly support unobviousness of the presently claimed invention, wherein the alkylation is performed in the presence of a Broensted acid and without the presence of a Lewis acid, with a Lewis acid subsequently being added and isomerization taking place in the copresence of the Broensted acid and the Lewis acid.

In Item 9 on page 4 of the Office Action mailed January 30, 2007, the Examiner contends that the Comparative Examples in Applicants' specification are not sufficient "because the comparisons are not being made with the closest prior art". This contention by the Examiner is respectfully traversed. To the contrary, it is respectfully submitted that, as indicated previously, Comparative Examples 1-7 can be compared to Frey, et al., and Comparative Example 8 can be compared to Lien, et al. and Olah. It is respectfully submitted that the Comparative Examples in Applicants' specification provide a fair comparison with the closest prior art.

Lien, et al. discloses rearrangement of certain secondary alkylbenzenes, wherein an isomerization reaction is performed to shift position of substituent alkyl groups on the benzene ring without rearrangement of the alkyl group itself. The isomerization process comprises contacting, under substantially anhydrous conditions and in the substantial absence of reactive hydrocarbons, a di-secondary alkylbenzene selected from the class consisting of the ortho isomer, the para isomer and mixtures thereof with at least an effective amount of BF_3 , and an amount of liquid HF at least sufficient to form a distinct acid phase; the contacting is carried out at a

temperature of not more than about -30°C; and removing HF and BF₃ from the acid phase under conditions to substantially avoid rearrangement reactions and recovering from the reaction product mixture a di-secondary alkylbenzene fraction containing the meta isomer. Note the paragraph bridging columns 5 and 6 of this patent. See also column 1, lines 58-71; column 2, lines 35-40 and 48-52; and column 4, lines 57-64.

It is respectfully submitted that this reference does not disclose, nor would have suggested, such process as in the present claims, including, in addition to an isomerization step, the alkylation in the presence of a Broensted acid and without the presence of a Lewis acid, and, moreover, wherein the aromatic compound represented by the general formula (1) is alkylated with the olefin in the presence of the Broensted acid and without the presence of the Lewis acid.

It is respectfully submitted that the additional teachings of Frey would not have rectified the deficiencies of Lien, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Frey discloses a process for the catalytic alkylation of hydrocarbons. This patent discloses admitting an alkylatable hydrocarbon to an alkylator, with concentrated or substantially anhydrous hydrofluoric acid being admitted. This patent discloses that for purposes of illustration benzene is chosen as the alkylatable hydrocarbon; but it is within the scope of the process described in the patent to alkylate also toluene or iso-paraffins such as isobutane or isopentane. See page 2, left-hand columns, lines 13-22. Note also page 3, right-hand column, lines 22-31.

Initially, it is noted that Frey discloses an alkylation process to alkylate hydrocarbons, while Lien, et al. discloses an isomerization reaction "of certain secondary alkylbenzenes". It is respectfully submitted that one of ordinary skill in the art concerned with in Lien, et al., to rearrange certain secondary alkylbenzenes,

would not have looked to the teachings of Frey. It is respectfully submitted that there would have been no motivation for combining the teachings of these references as applied by the Examiner, absent hindsight use of Applicants' disclosure, which of course is improper under 35 USC 103.

Furthermore, even assuming, arguendo, that the teachings of these references were properly combinable, such combined teachings would have neither disclosed nor would have suggested the presently claimed method, including, inter alia, the aromatic compound represented by the general formula (1) which is alkylated with the olefin, and/or wherein the alkylation is performed in the presence of a Broensted acid and without the presence of a Lewis acid, and advantages thereof, with subsequent addition of the Lewis acid whereby the isomerization is performed in the copresence of the Broensted acid and the Lewis acid.

Olah discloses a process for isomerizing paraffins and/or alkyl substituted aromatic hydrocarbons, the isomerizable hydrocarbons being selected from the group consisting of paraffins, alkyl substituted aromatic hydrocarbons, and mixtures thereof, the hydrocarbons being isomerized at low temperatures in the presence of a catalyst comprising (a) one or more Lewis acids of a specified formula, and (b) a strong Bronsted acid, preferably comprising a strong halogen-substituted acid such as fluorosulfuric acid, trifluoromethansulfonic acid, trifluoroacetic acid or mixtures thereof. Note the paragraph bridging columns 1 and 2 of Olah. See also column 3, lines 50-52.

Frey has been previously discussed, and deficiencies thereof have been previously discussed.

Initially, and as with Lien, et al. and Frey, it is emphasized that Olah discloses an isomerization process, while Frey discloses an alkylation process. Specific isomerizable hydrocarbons are described in connection with Olah. It is respectfully

submitted that one of ordinary skill in the art concerned with in Olah, pertaining to an isomerization reaction, would not have looked to the teachings of Frey; in particular, there would have been no motivation from the combined teachings of these references, or in any other manner to one of ordinary skill in the art, to motivate the combination of the teachings of these references. It is respectfully submitted that only through hindsight use of Applicants' disclosure, which is improper under 35 USC 103, would one have combined the teachings of Olah and Frey, as applied by the Examiner.

In any event, even assuming, arguendo, that the teachings of these references were properly combinable, such combined teachings would have neither disclosed nor would have suggested the combination of alkylation and isomerization steps as in the present claims, including in particular wherein the alkylation is performed in the presence of the Broensted acid and without the presence of the Lewis acid, while the isomerization is carried out in the copresence of these acids, and advantages thereof; and/or other features of the present invention as recited in the present claims, including, inter alia, the various materials used in the process, such as alkylation of the aromatic compound represented by the general formula (1), and/or wherein both processing steps are carried out in a same single reaction chamber, and advantages according to the present invention as discussed previously.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Authorization is herein given to charge any shortage in the fees,

including extension of time fees and excess claim fees, to Deposit Account No. 01-2135 (Case No. 396.44981X00), and please credit any excess fees to such deposit account.

Respectfully submitted,
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